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EUCLID FOR EXAMINATIONS.

By P. G. O'Connell.

When I was a boy it was once my pleasant duty to amuse a little girl of eight, for an hour or two on a summer's afternoon, in a beautiful garden which boasted a swing. The moments flew fast for a while, but gradually it became apparent that all forms of play had become wearisome. In despair I turned to my favourite subject, teaching. "Have you ever learnt Euclid?" I asked. "No. What is it?" With the aid of some old envelopes and a pencil we went through the old-fashioned proofs of the first five propositions. The fifth took some little time, but, when it had been mastered, the little maid had unconsciously assimilated the necessary fact that, if two sides of a triangle be unequal, the angles opposite those sides will also be unequal. Consequently, when, in developing the sixth proposition, I asked her to imagine that the two sides were not equal, she replied, "I can't." I tried to reason with her, but to all my arguments this logical, childish mind opposed only the one answer, "I can't."

Is it possible for a logical mind, which has assimilated a necessary fact, to conceive that that fact is untrue? The mathematician says it is possible; the child says it is not. When strictly questioned, with regard to Euclid I. 6, for instance, the mathematician evades the difficulty by saying, "Of course *I* cannot imagine that A B is unequal to A C, but I can imagine that some fool might suppose A B unequal to A C; and I should then say to him —"

This is where I join issue with the mathematician. I deny that it is possible for him to imagine that "some fool might *suppose* A B unequal to A C." Such imaginations are possible in the case of physical facts; but, in the case of this necessary fact, the utmost that he could imagine would be that some fool might *say* that he thought A B unequal to A C. The child, on the other hand, is perfectly logical. If you ask him to imagine that A B is unequal to A C, he replies, "I can't."

The average British schoolmaster forces his pupils to

repeat the words, "For, if A B be not equal to A C"; and the clever pupil humours him without losing sight of the fact that A B cannot be unequal to A C. But the average boy gains the impression that possibly A B is not equal to A C. This being contrary to reason, he learns to distrust his reason. Indeed, the mere suggestion that such theorems require a proof at all tends to make a boy distrust his reason; therefore a teacher who wishes to develop a child's intellect should never make him learn Euclid's "proofs," however interesting they may be to a mathematician.

Every theorem in Euclid is the statement of a necessary fact. Some are so obvious that every child can realise them at once; in others some children may require a little assistance. For instance, the necessary fact enunciated in III. 35 is easily realised by a mind which has already assimilated I. 47 and II. 5; but, to any other mind, the proof given in the text-books is a hindrance rather than a help. Therefore a teacher ought carefully to ascertain that I. 47 and II. 5 have been assimilated, before he presents III. 35.

The difficulty of assimilating I. 47 may be lessened by a preliminary study of the puzzle:—"To cut a square piece of paper into three parts which can be fitted together to form an oblong of given width." This having been solved, a boy can convince himself, by ocular demonstration, that the squares on the two sides of a right-angled triangle are equal to the two oblongs into which Euclid divides the square on the hypotenuse. But there will be no difficulty in assimilating I. 47, if the necessary facts, on which Euclid's proof depends, have been previously assimilated. The difficulty is manufactured by the teacher, who presents the necessary fact too soon; and the mind of the British boy is permanently injured by his plucky attempt to overcome this manufactured difficulty in a wrong way.

I know a worthy man, the senior mathematical master at one of our large schools, who makes his pupils learn by heart many such statements as that "The difference of the squares of two numbers is equal to the product of their sum and difference." Speaking of his pupils, he will say, "They *know* these facts, but they *will* not apply them." Sometimes I think he considers this a personal insult to himself. Of course they do not really know these facts.

They can repeat the words like parrots, but they have never realised the facts those words contain.

A few particular examples will render the above fact easy of digestion. This diagram :—

c c c c c
c c c c c
c c c c c
c c c
c c c

shows twenty-one articles arranged as the difference of the squares of five and two. This diagram :—

c c c c c c c
c c c c c c c
c c c c c c c

shows the same articles arranged as the product of seven and three. The general case may be illustrated by means of a post card and a pair of scissors, or a knife. When this has been done, a very little consideration will show that II. 5 and II. 6 are merely restatements of the old, familiar, necessary fact. Easy of digestion as this fact is, a few years of English school life often render a boy's mind incapable of digesting it.

As I hold that no one who cannot solve a fairly hard rider can boast of even a bowing acquaintance with "My Lady Geometry," who only admits to her intimacy those who never leave a rider unsolved, I will briefly outline a method, by which I think a private student might gain the power of solving the hardest rider :—Buy the best pair of compasses you can afford, and also a couple of set squares. Amuse yourself with these till you feel the want of a leading question. Then attack Euclid. Do not look at Euclid's constructions for problems until you have tried for some time to find out a construction for yourself. Treat all his theorems as necessary facts, needing careful assimilation. Before long you will very likely come to one which you cannot realise unaided. A glance at the references in Euclid's proof will perhaps be sufficient aid ; if not, read Euclid's explanation. Take stock nearly every day of the facts you have assimilated ; for, if you ever have a difficulty in realising a new necessary fact, it will be because you have not thoroughly assimilated some fact that preceded it. Do

not try to assimilate too much at a time, or you will upset your mental digestion. You might just as well try to eat a whole ox at a sitting. Solve as many riders as you can ; that is to say, satisfy your own intellect that you have discovered accurate constructions for the problems and that the theorems are true. No necessary fact needs a proof, though some require an explanation ; therefore do not trouble about academic proofs.

Owing to the careless way in which some text-books are compiled, you may come across a few riders which cannot be solved without assuming facts that have not yet been presented to you ; but, if you keep every such rider in your mind as something to go back to later on, you will soon become one of those who never leave a rider unsolved, and "My Lady Geometry" will become to you the sweetest and least exacting of friends. Is it necessary to add that she will, if you wish it, carry you successfully through any examination, even through one conducted by her foes ?

The last sentence will explain the title of this article. Experience has confirmed my preconceived opinion that, even for examination purposes, it is unwise to ask a boy to prove an obvious fact. When writing on higher mathematics the mathematician mentions, as obvious, many facts far less easy to realise than most of Euclid's theorems. Indeed it is reported of at least one famous mathematician that, when asked to explain a certain fact which he had mentioned as obvious, he replied, "I don't see it myself!" To the child also many things are obvious, though he cannot explain them. By telling a pupil, even indirectly, that they are *not* obvious, which is untrue, a teacher does very great harm, often rendering him incapable of realising facts which are obvious alike to the untaught child and to the philosopher.

The intelligence of the untaught child is proverbial, yet when Jack comes home from school a dullard at sixteen, his parents lay all the blame upon poor Jack, and send his younger brothers to the same schools. If they had retained the clear notions of cause and effect which Nature gave them in their childhood, they would attribute at least a part of Jack's stupidity to the cramping nature of his education. Moreover, this cramping of the mind often reacts upon the body, quite apart from the fact that those who starve the

mind are apt to starve the body too. I will give one case in order to show how it was cured.

During more than three years spent at one of our public schools, a boy grew less than half-an-inch. At sixteen he left, standing under five feet, and weighing six stone six. Certainly there was no disease, other than short sight, bad teeth and an impaired digestion. Indeed the boy was "as hard as nails." But, as he came of a family above the average in height and weight, his size was a disease in itself. The treatment was left to Nature, the boy being allowed to do almost exactly what he liked in school and out of school. Good food was supplied in abundance and variety, and time was allowed to eat it in. But even in this respect he was given perfect freedom, as is proved by the fact that he often went without lunch in order to improve his wind. He took to bicycling, sculling, and rowing, almost simultaneously, at the same time saying good-bye to doctors, discipline, and drudgery. For the first four months the boy neither grew nor put on weight. Nature required coaxing before she would consent to forget the insults that had been offered to her, but in the two succeeding years the boy grew nearly seven inches, and increased his weight by about thirty-five pounds.

The long coaxing that Nature required seems to me to show that the boy narrowly escaped becoming a physical dwarf for life. How many English boys escape becoming mental dwarfs for life? When Jack comes home from school a dullard at sixteen, how often is it thought advisable to coax Nature by giving Jack's brain complete rest for a year? I think I am right in saying that this rest for the brain is only prescribed when serious physical ailments have been produced.

Even in the medical profession there are few who recognise dullness of intellect as a disease. Yet it is merely a disease, to a certain limited extent hereditary, but usually induced by bad education, and nearly always curable. Insanity the doctors dimly recognise; idiocy they sometimes partially cure; but for dullness of intellect they can suggest no remedy save the birch, which only intensifies the disease.

THE FERRY OF DREAMS.

By Caryl Battersby.

"Boatman, ere thou take the tide,
Tell me who are these that ride
With thee to the further side."

"All thy dreams beneath the sun,
Golden fancies never won,
Deeds of glory left undone."

"Boatman, let me come with thee,
For I may not parted be
From the dreams that dwelt with me."

"Thou shalt stay, but these must go,
Even as the birds that know,
Ere it come, the time of snow."

"Boatman, when the birds shall be
Here again from over-sea,
Will my dreams come back to me?"

"Nay, but some dark eventide
I will take thee by my side
To the land where they abide."